TABLE

For facilitating the Computation of Cast-Iron Beams; such as are usually employed for Bearers in Buildings and on Railways.

ARGUMENT.—Inches and tenths in the depth of the section.

In.	·0	·1	·2	·3	·4	·5	·6	·7	·8	·9
	Tons.	Tons.	Tons.	Tons.	Tons.	Tons.	Tons.	Tons.	Tons.	Tons.
0	0·0000	0·0038	0·0152	0·0342	0·0608	0·0950	0·1368	0·1862	0·2431	0·3078
1	0·3800	0·4599	0·5473	0·6422	0·7448	0·8550	0·9728	1·0982	1·2313	1·3718
2	1·5200	1·6758	1·8393	2·0102	2·1888	2·3750	2·5688	2·7702	2·9792	3·1958
3	3·4200	3·6518	3·8912	4·1382	4·3928	4·6550	4·9248	5·2022	5·4872	5·7798
4	6·0800	6·3878	6·7032	7·0262	7·3568	7·6950	8·0408	8·3942	8·7552	9·1238
5	9·5000	9·8838	10·2752	10·6742	11·0808	11·4950	11·9168	12·3462	12·7832	13·2278
6	13·6800	14·1398	14·6072	15·0822	15·5648	16·0550	16·5528	17·0582	17·5712	18·0918
7	18·6200	19·1558	19·6992	20·2502	20·8088	21·3750	21·9488	22·5302	23·1192	23·7158
8	24·3200	24·9318	25·5512	26·1782	26·8128	27·4550	28·1048	28·7622	29·4272	30·0998
9	30·7800	31·4678	32·1632	32·8662	33·5768	34·2950	35·0208	35·7542	36·4952	37·2438
10	38·0000	38·7638	39·5352	40·3142	41·1008	41·8950	42·6968	43·5062	44·3232	45·1478
11	45·9800	46·8198	47·6672	48·5222	49·3848	50·2550	51·1328	52·0182	52·9112	53·8118
12	54·7200	55·6358	56·5592	57·4902	58·4288	59·3750	60·3288	61·2902	62·2592	63·2358
13	64·2200	65·2118	66·2112	67·2182	68·2328	69·2550	70·2848	71·3222	72·3672	73·4198
14	74·4800	75·5478	76·6232	77·7062	78·7968	79·8950	81·0008	82·1142	83·2352	84·3638
15	85·5000	86·6438	87·7952	88·9542	90·1208	91·2950	92·4768	93·6662	94·8632	96·0678
16	97·2800	98·4998	99·7272	100·9622	102·2048	103·4550	104·7128	105·9782	107·2512	108·5318
17	109·8200	111·1158	112·4192	113·7302	115·0488	116·3750	117·7088	119·0502	120·3992	121·7558
18	123·1200	124·4918	125·8712	127·2582	128·6528	130·0550	131·4648	132·8822	134·3072	135·7398
19	137·1800	138·6278	140·0832	141·5462	143·0168	144·4950	145·9808	147·4742	148·9752	150·4838
20	152·0000	153·5238	155·0552	156·5942	158·1408	159·6950	161·2568	162·8262	164·4032	165·9878
21	167·5800	169·1798	170·7872	172·4022	174·0248	175·6550	177·2928	178·9382	180·5912	182·2518
22	183·9200	185·5958	187·2792	188·9702	190·6688	192·3750	194·0888	195·8102	197·5392	199·2758
23	201·0200	202·7718	204·5312	206·2982	208·0728	209·8550	211·6448	213·4422	215·2472	217·0598
24	218·8800	220·7078	222·5432	224·3862	226·2368	228·0950	229·9608	231·8342	233·7152	235·6038
25	237·5000	239·4038	241·3152	243·2342	245·1608	247·0950	249·0368	250·9862	252·9432	254·9078
26	256·8800	258·8598	260·8472	262·8422	264·8448	266·8550	268·8728	270·8982	272·9312	274·9718
27	277·0200	279·0758	281·1392	283·2102	285·2888	287·3750	289·4688	291·5702	293·6792	295·7958
28	297·9200	300·0518	302·1912	304·3382	306·4928	308·6550	310·8248	313·0022	315·1872	317·3798
29	319·5800	321·7878	324·0032	326·2262	328·4568	330·6950	332·9408	335·1942	337·4552	339·7238
30	342·0000	344·2838	346·5752	348·8742	351·1808	353·4950	355·8168	358·1462	360·4832	362·8278
31	365·1800	367·5398	369·9072	372·2822	374·6648	377·0550	379·4528	381·8582	384·2712	386·6918
32	389·1200	391·5558	393·9992	396·4502	398·9088	401·3750	403·8488	406·3302	408·8192	411·3158
33	413·8200	416·3318	418·8512	421·3782	423·9128	426·4550	429·0048	431·5622	434·1272	436·6998
34	439·2800	441·8678	444·4632	447·0662	449·6768	452·2950	454·9208	457·5542	460·1952	462·8438
35	465·5000	468·1638	470·8352	473·5142	476·2008	478·8950	481·5968	484·3062	487·0232	489·7478
36	492·4800	495·2198	497·9672	500·7222	503·4848	506·2550	509·0328	511·8182	514·6112	517·4118
37	520·2200	523·0358	525·8592	528·6902	531·5288	534·3750	537·2288	540·0902	542·9592	545·8358
38	548·7200	551·6118	554·5112	557·4182	560·3328	563·2550	566·1848	569·1222	572·0672	575·0198
39	577·9800	580·9478	583·9232	586·9062	589·8968	592·8950	595·9008	598·9142	601·9352	604·9638
40	608·0000	611·0438	614·0952	617·1542	620·2208	623·2950	626·3768	629·4662	632·5632	635·6678
41	638·7800	641·8998	645·0272	648·1622	651·3048	654·4550	657·6128	660·7782	663·9512	667·1318
42	670·3200	673·5158	676·7192	679·9302	683·1488	686·3750	689·6088	692·8502	696·0992	699·3558
43	702·6200	705·8918	709·1712	712·4582	715·7528	719·0550	722·3648	725·6822	729·0072	732·3398
44	735·6800	739·0278	742·3832	745·7462	749·1168	752·4950	755·8808	759·2742	762·6752	766·0838
45	769·5000	772·9238	776·3552	779·7942	783·2408	786·6950	790·1568	793·6262	797·1032	800·5878
46	804·0800	807·5798	811·0872	814·6022	818·1248	821·6550	825·1928	828·7382	832·2912	835·8518
47	839·4200	842·9958	846·5792	850·1702	853·7688	857·3750	860·9888	864·6102	868·2392	871·8758
48	875·5200	879·1718	882·8312	886·4982	890·1728	893·8550	897·5448	901·2422	904·9472	908·6598

DESCRIPTION AND USE OF TABLE,

FOR CALCULATING STRENGTH OF CAST-IRON BEAMS.

THE numbers in the foregoing table are of the greatest use in estimating the strength and dimensions of cast-iron beams, when employed as girders or breast-summers in large and important structures. They have been computed for the limit of safety, from the results of experiments performed on a medium quality of the material, and may therefore, be considered as better adapted for general practice, than if they had been obtained from metal approximating to either extreme of hardness or softness, and in consequence possessing a higher degree of rigidity or flexibility, according to the nature of the approximated extreme. The numbers in the body of the page are expressed in tons and decimals of a ton; those in the left-hand column are inches in the depth of the transverse section, and those at the top of the columns, numbering from 0 to 9, are tenths of an inch also in the depth of the transverse section, so that the table embraces a depth of section for every tenth of an inch from zero to forty-nine inches, and is, consequently sufficiently extensive for every practical purpose, as it seldom happens, even in the very largest works, that a section is required exceeding four feet in the direction of the strain.

The chief advantage which this table possesses over others of a similar character that have long been in use, consists in its brevity and the extent of its application; and these advantages it derives from the circumstance of being computed for one inch of thickness or breadth of section, and one foot in the length of bearing or distance between the supports; this in some respects, is a very great convenience, and more especially, where extensive calculations are necessary; but it is in some degree objectionable, as it requires a subsidiary multiplication and division to obtain the final result; this objection however, has very little force when placed against the advantages which are otherwise afforded by the arrangement.

The following examples will elucidate the use of the table under various circumstances, and, being of a practical nature, it is hoped they will be found of value to the mechanic, in guiding him to the calculation of similar cases that may happen to present themselves in the course of his practice.

Example 1.—A cast-iron beam of a regular rectangular form both in elevation and section, is loosely supported in a horizontal position on two walls at the distance of 26 feet from each other; what load will it sustain with safety applied at the middle of its length, or at an equal distance from each wall, supposing the breadth of the section to be 2¼ inches and the depth 30 inches?

Now, the arrangement indicated by this example is perfectly obvious, and therefore requires no diagram to illustrate it; and the argument with which the table is to be entered is simply the depth of the section in inches; consequently, under zero or 0 at the top of the table, and opposite 30 in the left-hand column we find the number 342, which is the number of tons that a beam of the same depth as that which is given will support, when the breadth is one inch, and the length of bearing one foot. But, according to the laws of resistance, the strength is directly as the breadth when the depth is given, and inversely as the length of bearing; that is, *multiply the tabular strength by the given breadth of section, and divide by the length of bearing for the weight which the beam can sustain with safety under the given conditions.*

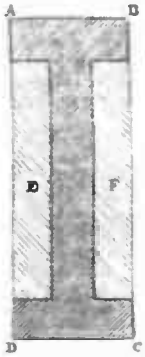
Hence we have $342 \times 2\frac{1}{4} = 855$, and this divided by 26, gives $855 \div 26 = 32\frac{23}{26}$ tons, the load that the given beam can sustain at the middle of its length; but this includes the effect produced by the weight of the beam itself, which ought always to be taken into consideration; for when omitted, as is too frequently the case on many important occasions, the omission may be attended with very serious consequences.

It is demonstrable by the principles of mechanics, that the effect produced by the weight of the beam itself in augmenting the strain, is the same as if one-half that weight were applied to the middle of its length, and in consequence of this mechanical condition, the calculated strength must always be diminished by half the weight of the beam, when that weight itself can be determined, which indeed can always be done when the dimensions of the beam are known. Now in the present instance, the area of the middle transverse section is 75 square inches, for $30 \times 2\frac{1}{4} = 75$, and since the section is uniform throughout the length, the weight of one foot in length for cast-iron of medium specific gravity may be taken at 240lbs., that is, 3·2lbs. for a bar one inch square and one foot long; consequently, for 13 feet or half the length of the beam, it is $240 \times 13 = 3{,}120$lbs. or $1\frac{1}{20}$ tons, for the effect produced by the weight of the beam, therefore, by subtracting this from the calculated strength, we get $32\frac{23}{26} - 1 = 31\frac{3}{26}$ tons, the safe load on the middle of the beam.

Now, all this is perfectly obvious when a beam of the given form is supported at the ends and loaded in the middle of its length, but when the load is uniformly diffused between the points of support, the load as calculated above may be doubled without producing any difference in the effect of the straining force as referred to the central rupture, the deflection only being varied in consequence of the uniform load. But if the ends of the beam be firmly fixed into the walls, instead of being merely supported on them, then the load which it can safely sustain under this latter condition, when applied at the middle of the length, is one-half more than when the ends are loose, and the same thing holds when the load is uniformly diffused throughout the length.

However useful the foregoing table may be when applied to the calculation of beams of which the transverse section is simply rectangular, it becomes much more so when applied to beams of that form of section now so generally employed in flooring and in the construction of railways, viz., those which have a flange or feather on the upper and the lower side, known as the *double flanged*, or **I** *formed section.*

The formula which supplies the rule for this form of beam is of rather a complicated character, and in consequence is somewhat difficult to apply; but when we consider the section as being equal to the difference between two rectangular sections, the difficulty disappears, and the calculation is performed by our table with the greatest imaginable ease.



The section thus constituted is represented by the dark shaded part of the marginal figure, the lighter shaded parts E and F being left out to form the feathers or flanges at the upper and lower sides of the beam.

Here then it is obvious that if we consider the section to be an entire rectangle, as denoted by ABCD, the strength of that section may be calculated as in the preceding case. And, in like manner, the parts marked E and F may either be considered as forming two independent rectangular sections, or they may be brought together and considered as one section only, being of precisely the same value as to strength in either case; then, if the strength of the rectangular section, which is made up of the parts marked E and F, be subtracted from the strength of the entire section ABCD, the remainder will be the strength of the double flanged or **I** formed section so universally employed in the construction of railway arches. It may, however, be proper to remark, that the strength of the section denoted by E and F, must undergo some modification before the subtraction takes place, for it is a well established fact, that the metal which is to be withdrawn, is not in the same mechanical condition with respect to strength when incorporated with the mass, that it is when considered by itself, or in the state of detachment; it therefore becomes necessary to reduce the strength of that which is to be subtracted when calculated by the table, in the proportion of the whole depth of the section, to the depth of the middle part denoted by the lighter shaded portions, E and F.

Example 2. Let the whole depth of a double

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